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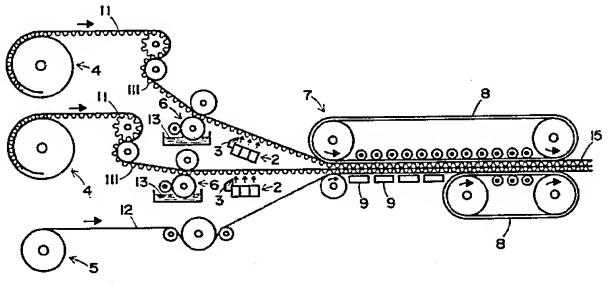
(54) Apparatus for producing corrugated cardboard.

(57) An apparatus for producing corrugated cardboard has means (6) for applying a suspension of raw starch in water to the crests (111) of a corrugated core of at least one half-lined corrugated paper (11); means (2) for directing reheated dry steam onto the suspension to cause gelation of the starch; and means (7), including heater plates (9), for pressing and bonding the paper (11) to a liner (12).



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AIKI KOGYO KABUSHIKI KAISHA Ref: 50/2289/02

APPARATUS FOR PRODUCING CORRUGATED CARDBOARD

As is well known, corrugated cardboard i.e. cardboard with a corrugated core, is produced by forming a half-lined corrugated paper by bonding a corrugated paper and a liner to one another, and then bonding another liner to the half-lined corrugated paper. In some cases, two or more sheets of half-lined corrugated papers are laminated to constitute a "double-backer" or thicker cardboards.

A synthetic resin adhesive such as an emulsion of polyvinyl acetate can be used most suitably as the adhesive for the bonding. However, to cope with the demand for lower production cost, efforts have been made to use less-expensive adhesives. As an example of such efforts, it has been attempted to use raw starch dispersion, i.e. starch particles dispersed and suspended in water. This dispersion is applied to the corrugated paper and, after laying the liner on the corrugated paper, heat and pressure are applied to cause gelation of the starch dispersion into a starch paste adhesive.

The heating under pressure is usually conducted by moving the liner in sliding contact with an array of heat plates, i.e. metallic plates which serve as a heating medium. The heat plates, however, require a considerably large installation area and consume an impractically large amount of energy. In addition, the heat plates often cause undesirable scratches and warp in the corrugated cardboard product.

To obviate this problem, it has been proposed to heat and gelate the raw starch dispersion applied to the half-lined corrugated paper, in advance to the superposition of the paper and the liner (see Japanese Patent Publication No. 24658/1972).

This method is superior in that it dispenses

with the use of the heat plates but has caused a new problem that the yield, i.e. production rate, is low. Usually, the gelation by heat of the raw starch dispersion if effected by blowing steam from nozzles against the applied raw starch dispersion. The production rate of the corrugated cardboard will be increased by increasing the gelation speed by supplying sufficiently large amount of heat to the raw starch dispersion. However, the normally used steam of low pressure, e.g., 0.2 Kg/cm^2G, has a temperature of 80 to 85^{o} at the highest as measured at the nozzle outlet. With such steam, it is not possible to provide sufficient heat.

In order to develop a higher temperature, steam of a higher pressure was used experimentally. This, however, proved unsatisfactory, owing to the high energy of the jetted steam undesirably blowing of the raw starch dispersion applied to the half-lined corrugated paper.

Also, blowing of a large amount of steam caused an excessive moistening of the half-lined corrugated paper as a result of condensation of the steam. The moistening of the corrugated paper serves to obviate the warp of the corrugated cardboard product caused by the use of the heat plates, but this merit is cancelled by lower production efficiency attributable to an excessively long time required for the drying of the product. If the moistened corrugated cardboard is sent to the box-making process without drying, various problems are caused, such as dimensional change and insufficient strength of the box.

According to the experience of the present inventor, a higher bonding strength is obtained by half-gelation of the raw starch dispersion into the state of semi-paste and effecting supplementary heating during and after the pressing to turn the

semi-paste into perfect paste, rather than perfectly gelating the raw starch dispersion at once prior to the pressing. This can be attributed to the fact that the adhesive in the state of semi-paste exhibits greater penetration into the tissue of the liner paper. From this point of view, the art shown in Japanese Patent Publication No.24658/1972 preferably makes use of the conventional heat plates, rather than relying solely thereon.

Accordingly, it is a primary object of the present invention to provide a production apparatus of the type in which the raw starch dispersion is gelated first imperfectly and then changed into adhesive by the assistance of the heat plates, thus overcoming the above-described problems of the prior art.

According to the present invention, an apparatus for producing corrugated cardboard comprises means for continuously supplying at least one half-lined corrugated paper and a liner, means for applying a suspension of raw starch in water to the crests of the corrugations of the half-lined corrugated paper, means for blowing steam against the applied raw starch thereby to cause partial gelation of the raw starch, means for forming the corrugated cardboard by pressing the at least one half-lined corrugated paper and the liner to bond them together, and means for continuously taking up the thus formed corrugated cardboard; wherein the means for blowing steam includes a plurality of tubular bodies extending across the moving direction of the half-lined corrugated paper, in use, adjacent to the half-lined corrugated paper, each tubular body having multiple nozzles in its surface, which faces, in use, the applied raw starch, the interior of each tubular body being divided by ducting for high pressure steam, into a first manifold and a second manifold which

communicate with one another through steam passages, the second manifold accomodating a pipe supplying low pressure steam into the second manifold, the means for blowing steam further including an air blowing means disposed at the upstream end thereof as viewed in the moving direction of the half-lined corrugated paper and having a slit which blows air, in use, towards the applied raw starch in a direction inclined towards the moving direction; and wherein the means for forming the corrugated cardboard includes a heat plate arrranged, in use, to contact and heat the liner during pressing the at least one half-lined corrugated paper and the liner.

The new apparatus offers an increase in the production efficiency by realizing a higher speed of production without any degradation of the corrugated cardboard product. If the increase in the production speed is not a matter of concern, the apparatus can effect the production with reduced energy consumption.

The apparatus makes use of steam of low pressure as the heat source. An important feature, however, is that this low pressure steam is reheated to become dry steam which is blown through the nozzles against the raw starch dispersion. The steam pressure preferably ranges between 0.1 and 0.3 Kg/cm^2G, usually around 0.2 Kg/cm^2G. Because of the reheating, it is possible to obtain easily a high steam temperature of 125 to 130^{o}C at the nozzle outlets. By the use of dry steam of this high temperature, it is possible to avoid too strong an impingement of the steam and also excessive moistening of the corrugated cardboard.

The means for reheating the steam is the steam of a high pressure, preferably at 10 to 12 Kg/cm^2G, in the ducting.

The heat possessed by this steam is utilized

through heat exchange, namely, the low pressure steam is heated indirectly by the high pressure steam. The high pressure steam may then have its pressure reduced and be used at the low pressure steam.

An example of an apparatus constructed in accordance with the invention is illustrated in the accompanying drawings, in which:-

Figure 1 is a diagrammatic side elevation;

Figure 2A is a vertical cross-sectional view of the steam blowing means;

Figure 2B is a partly cut-away plan of the steam blowing means as shown in Figure 2A;

Figure 2C is a partly cut-away side elevation of the steam blowing means;

Figure 3 is a sectional diagram illustrating the concept of the steam reheating and blowing means;

Figure 4A is a diagrammatic vertical section showing a hood covering the area where the steam is blown;

Figure 4B is a vertical cross section corresponding to Figure 4A;

Figure 5A is a side elevation of an optional modification of part of the apparatus; and,

Figure 5B is an enlarged sectional view of the part shown in Figure 5A.

As illustrated, an apparatus 1 for producing a corrugated cardboard essentially comprises, as shown in Figure 1, means 4 for continuously supplying at least one half-lined corrugated paper 11 (two sheets of the paper in the illustrated embodiment), means 5 for continuously supplying a liner 12, means 6 for applying an aqueous dispersion of raw starch 13 to crests 111 of the corrugations of the corrugated core of the half-lined corrugated paper, means 2 for blowing steam against the applied raw starch dispersion thereby to cause partial gelation of the raw starch dispersion into paste, means 7 for forming the corrugated cardboard by pressing the at least one

half-lined corrugated paper 11 and the liner 12 to bond and unite them together, and means 8 for continuously taking up the thus formed corrugated cardboard. As shown in Figure 2, the means 2 for blowing steam is housed by a plurality of cases 21A, 21B, 21C in the form of tubular bodies disposed near and below the half-lined corrugated paper and extending across the moving direction of the half-lined corrugated paper. Each tubular body has multiple nozzles 24, 24 ... in its upper surface. The space in each in each tubular body is divided by intergral central pipes 23, 23 constituting ducts for high pressure steam into a first upper manifold 28 and a second lower manifold 26 which communicate with one another through steam passages 27 formed between the adjacent pipes 23, 23.

The lower manifold 26 accomodates a pipes 22 for supplying low presure steam. An air blowing means 3 is disposed on the upstream side of the upstream tubular body as viewed in the moving direction of the half-lined corrugated paper and has slit 31 which blows air in a direction inclined towards the moving direction of the half-lined corrugated paper 11. The means 7 for forming the corrugated cardboard includes means for contacting and heating the liner 12, e.g., heat plates 9, 9, 9 ... in the illustrated construction, during pressing of the at least one half-lined corrugated paper 11 and the liner 12.

The low pressure steam, supplied through the pipe 22 at a rate regulated by a regulating valve, flows into the lower manifold 26 through nozles 221 and then flows through the passgaes 27 while being heated by the high pressure steam flowing through the pipes 23, 23 at both sides of each passage 27 up to the desired temperature. The heated low pressure steam is then blown through the nozzles 24 into the upper manifold 28.

An arrangement as shown in Figure 3 is preferably used when it is desired to utilize the heat possessed by the high pressure steam in advance of the reduction of the pressure of this steam to low pressure. Thus, the high pressure steam from a high pressure steam source STM is introduced into the pipes 23 through a valve Vs_1 and, after the heat exchange, delivered to a pressure reducing valve R in which the pressure is reduced to a low level. The low pressure steam is then introduced through a valve Vs_2 and jetted from the nozzles in the pipe 22. A symbol T represents a steam trap.

The air blowing means disposed at the upstream side of the steam blowing means receives air which is supplied from a compressed air source AIR after a pressure regulation by a valve V_A, and blows air through the slit 31 to form a stream of air which is inclined in the direction of flow of the half-lined corrugated paper 11. This air plays two roles, one of which is to dilute the steam blown through the nozzles 24 significantly to lower the temperature thereof so as to create such a condition that the steam impinges gently near the slit and then, at further points, progressively strongly. If the steam at a high temperature impinges strongly and at a large rate on the raw starch dispersion applied to the crests of the corrugations of the half-lined corrugated paper, the gelation takes place rapidly only in the surface region of the starch dispersion to produce a surface solidification of the same, and failing to accomplish the desired uniform half-gelation of the whole of the starch dispersion. Clearly, such surface solidification of the starch dispersion is not desirable for the adhesion of the corrugated paper and the liner to one and other.

Another role of the air blown through the slit

31 is to prevent undesirable half-gelation of the raw starch dispersion in the applying means which may otherwise occur due to heating of the dispersion and the applying means by a flow component of the steam directed towards the upstream side along the half-lined corrugated paper.

The width of the slit 31 and angle of inclination of the air stream, as well as the flow rate and velocity of the air, will be suitably and experimentally determined in accordance with conditions peculiar to each case.

Two or, preferably, three or more steam blowing means are arranged in a side-by-side fashion, and a part or whole of the same is used selectively. A demand for a high rate of production requires correspondingly large heat input to the raw starch dispersion and, hence, a greater number of the steam blowing means to be put into operation. Usually, the operation is started up with only one steam blowing means, i.e., the steam blowing means disposed at the upstream end, and the number of steam blowing means taking part in the operation is gradually increased.

The steam STM of high pressure is supplied to the heat plate 9 after a pressure adjustment by means of a valve Vs_3.

In the conventional corrugated cardboard production apparatus in which the gelation of the raw starch dispersion is effected solely by the heat plates, the heat plates are supplied with steam of a considerably high pressure, e.g., 10 to 14 Kg/cm^2G, i.e., steam at a considerably high temperature. In the new apparatus, the heat required for the gelation is shared by both of the blowing steam and the heat plates at the optimum ratio so that a steam of a somewhat lower pressure, e.g., 3 to 6 Kg/cm^2G, is used suitably.

In order to make sure of the supply of

sufficient heat for the gelation of the raw starch dispersion, it is advisable to use a heat preserving hood 100 as shown in Figure 4. The heat preserving hood is disposed to cover the region opposite to, i.e. facing the nozzles of, the steam blowing means across the half-lined corrugated paper 11 and has such a length that both ends of the hood extend beyond both edges of the half-lined corrugated paper as illustrated. The hood 100 is provided at its upper portion with an exhaust duct 101 to provide a draught out the hood.

By the use of this hood, the steam is distributed as indicated by arrows so that any temperature difference, which may develop between the central portion and both edge portions of the half-lined corrugated paper is obviated to ensure a uniform heating and, hence, a uniform gelation of the raw starch dispersion.

On the other hand, in the production of the corrugated cardboard employing, for example, reienforced core treated with resin, the corrugated sheet is less liable to absorb the moisture. Therefore, if the heating steam is applied immediately after the application of the raw starch dispersion, the bonding strength is lowered owing to insufficient impregnation of the starch occured in the course of the half-gelation. In such a case, it is preferred to use a humidifying means as shown in Figure 5. This humidifying means is disposed at the upstream side of the means 6 for applying the raw starch dispersion, and is composed of a hood 200 covering the core, i.e., the corrugated core, of the half-lined corrugated paper 11 and one or, preferably, a plurality of nozzles 201 opening within the hood 200 and adapted to blow the steam against the core. The hood 200 preferably covers the region where a roll 203 is disposed, in order to preheat the

half-lined corrugated paper.

In operation, the crests of the corrugated paper are suitably humidified and heated beforehand by the humidifying means, so that the applied raw starch dispersion impregnates promptly and the undersirable low bonding strenth is avoided even if the steam is blown immediately after the application of the raw starch dispersion. The humidification can be made by a steam of a comparatively low pressure, e.g., 0.2 to 0.3 Kg/cm^2G. Thus, the high pressure steam after the heating of the low pressure steam, as well as the steam after the heating of the heat plates, can suitably be used as the humidifying steam after a pressure reduction as required.

The apparatus can have various forms. For instance, the illustrated steam blowing means 5 can be substituted by various other structures which can perform the sames function as the illustrated means 2. It is also advisable to provide a driving means incorporating a rack driven by an electric motor and a pinion so as to drive the steam blowing means 2 up and down as required. Such an arrangement offers an appreciable advantage in the maintenance through, for example, facilitating the cleaning of the pan for receiving the raw starch dispersion and the dipersion applying roller.

The addition or modification as explained above will be readily practiced by those skilled in the art.

The new apparatus brings about various advantages. First of all, it is to be noted that the apparatus provides a remarkable increase in the yield or production rate of the corrugated cardboard. As explained before, this is achieved by such an arrangement that the heat required for the gelation of the raw starch dispersion is shared by the low pressure steam blown to the raw starch dispersion and the heat plates at the optimum balance of heat input

ratio therebetween. If the increase of the yield or production rate is not a matter of concern, the apparatus permits the production of corrugated cardboard with reduced energy consumption.

Another advantage brought about by the new apparatus resides in an improvement in the quality of the corrugated cardboard product. More specifically, the apparatus eliminates the undesirable warp and line cracking of the corrugated cardboard. In the conventional apparatus in which the heating of the raw starch dispersion is effected by the heat plates solely, a considerably large amount of heat is provided from the heat plates so that a large difference of heat input is developed between the heated side and non-heated side of the half-lined corrugated paper, and this may undersirably warp the product. In addition, since the heat plates have to be heated to a high temperature, e.g. 170°C, the liner is inevitably deteriorated by the heat as a result of contact with the heat plates. Consequently, the strength is lowered and causes line cracking in the product. On the other hand, the gelation of the raw starch dispersion solely by the blowing of the steam tends to cause a warp of the corrugated cardboard product owing to excessive moisture resulting from the use of too large an amount of heating steam. It is quite advantageous that all of these problems can be avoided by the use of the new apparatus.

From the foregoing description, it will be understood that the apparatus is useful and effective in the production of corrugated cardboard, particularly of the double-facer type.

CLAIMS

1. An apparatus for producing corrugated cardboard, the apparatus comprising means (4,5) for continuously supplying at least one half-lined corrugated paper (11) and a liner (12), means (6) for applying a suspension of raw starch in water to the crests of the corrugated paper, means (2) for blowing steam against the applied raw starch thereby to cause partial gelation of the raw starch, means (7) for forming the corrugated cardboard by pressing the at least one half-lined corrugated paper and the liner to bond them together, and means (8) for continuously taking up the thus formed corrugated cardboard; wherein the means for blowing steam includes a plurality of tubular bodies (21A,21B..) extending across the moving direction of the half-lined corrugated paper, in use, adjacent to the half-lined corrugated paper, each tubular body having multiple nozzles (24) in its surface, which faces, in use, the applied raw starch, the interior of each tubular body being divided by ducting for high pressure steam, into a first manifold (28) and a second manifold (29) which communicate with one another through steam passages (27), the second manifold accomodating a pipe (22) for supplying low pressure steam into the second manifold, the means for blowing steam further including an air blowing means (3) disposed at the upstream end thereof as viewed in the moving direction of the half-lined corrugated paper and having a slit (31) which blows air, in use, towards the applied raw starch in a direction inclined towards the moving direction; and wherein the means for forming the corrugated cardboard includes a heat plate (9) arranged, in use, to contact and heat the liner during pressing the at least one half-lined corrugated paper (11) and the liner.

2. An apparatus according claim 1, further comprising a heat-preserving hood (100) facing the nozzles (24) of the means for blowing steam against the half-lined corrugated paper and long enough to extend, in use, beyond both edges of the half-lined corrugated paper (11), the heat-preserving hood being provided with an exhaust duct (101) to provide a draught out of the hood.

3. An apparatus according to claim 1 or claim 2, further comprising a humidifying means (200) disposed upstream, as viewed in the moving direction of the half-lined corrugated paper, of the means (6) for applying the suspension of raw starch, the humidifying means including a hood covering the corrugated core of the half-lined corrugated paper and one or more nozzles (201) opening in the hood and arranged, in use, to blow steam against the core.

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FIG. 1.

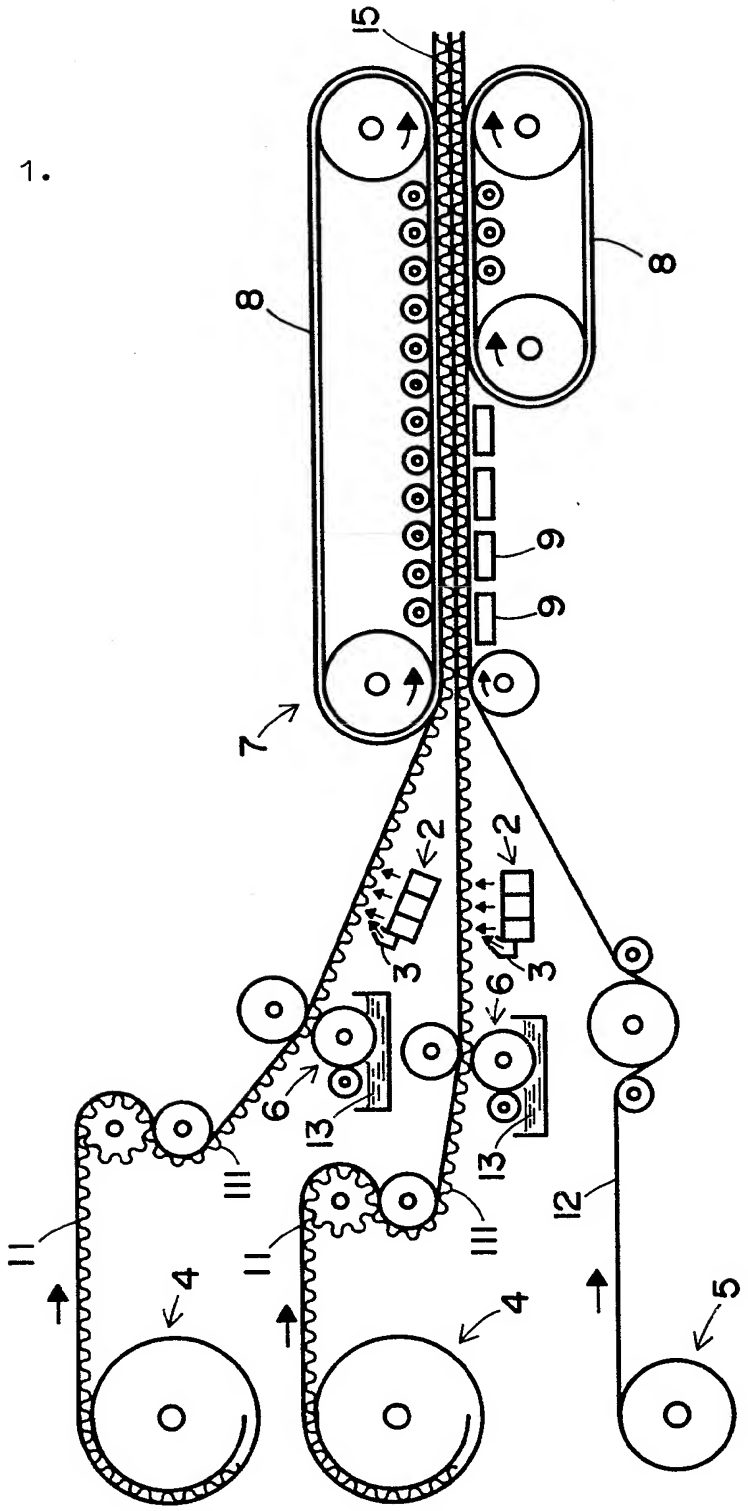


FIG. 2A.

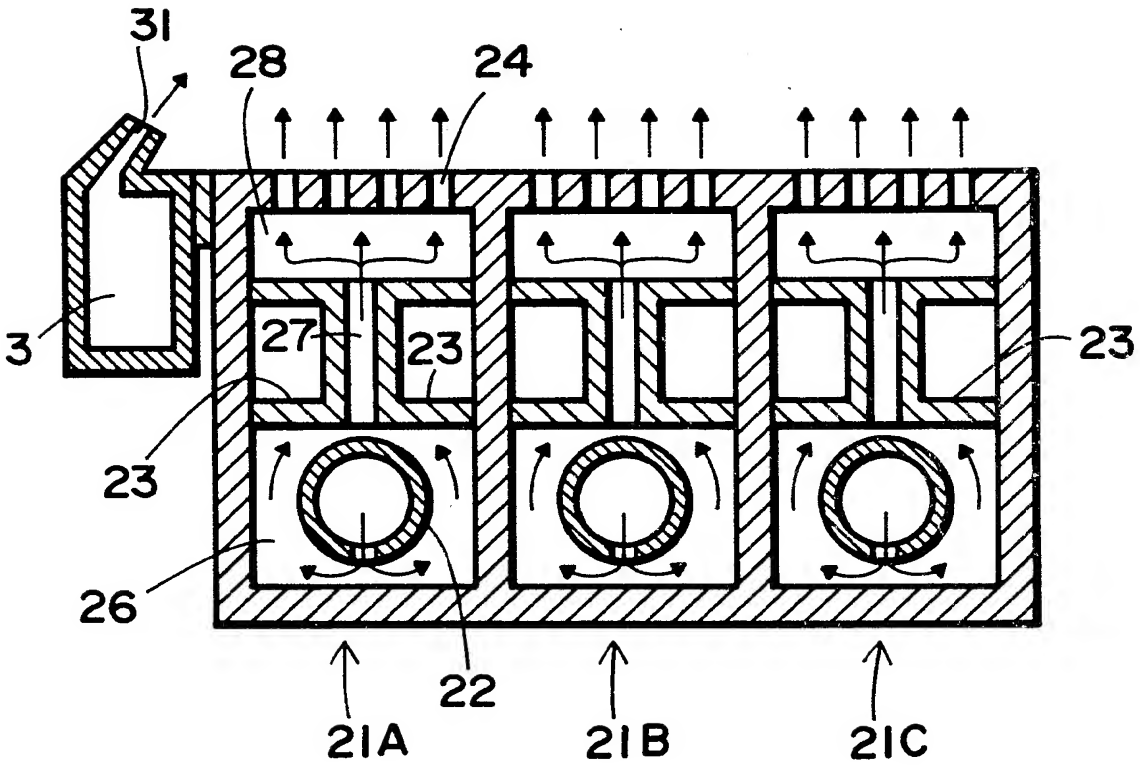


FIG. 2B.

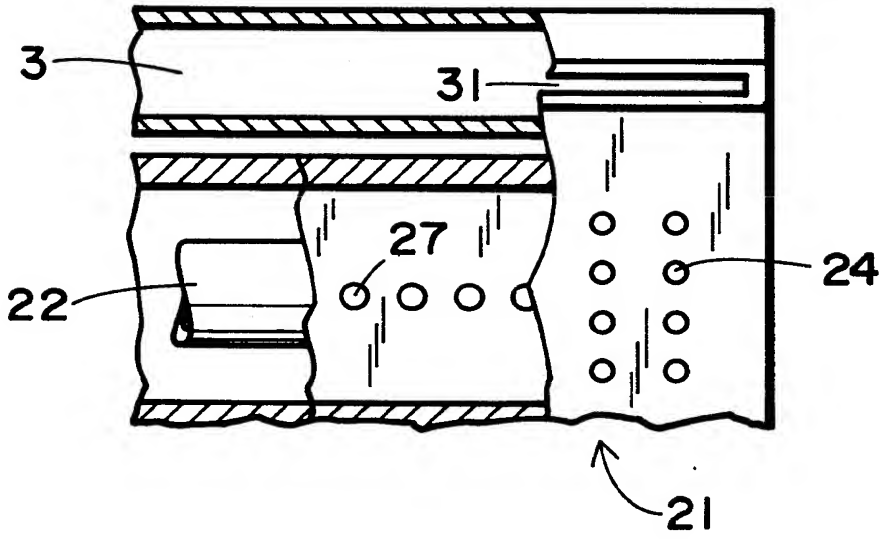


FIG. 2C.

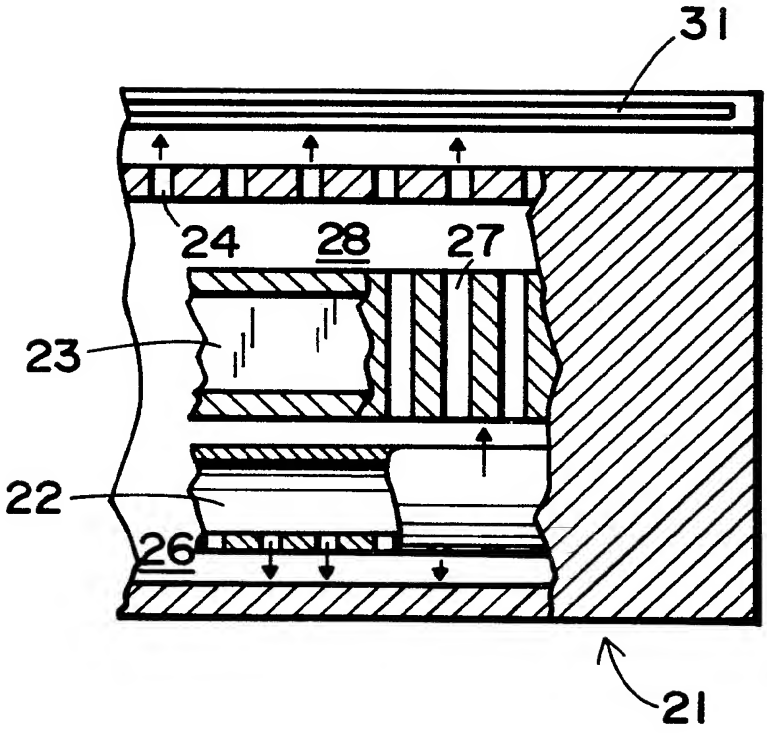


FIG. 3.

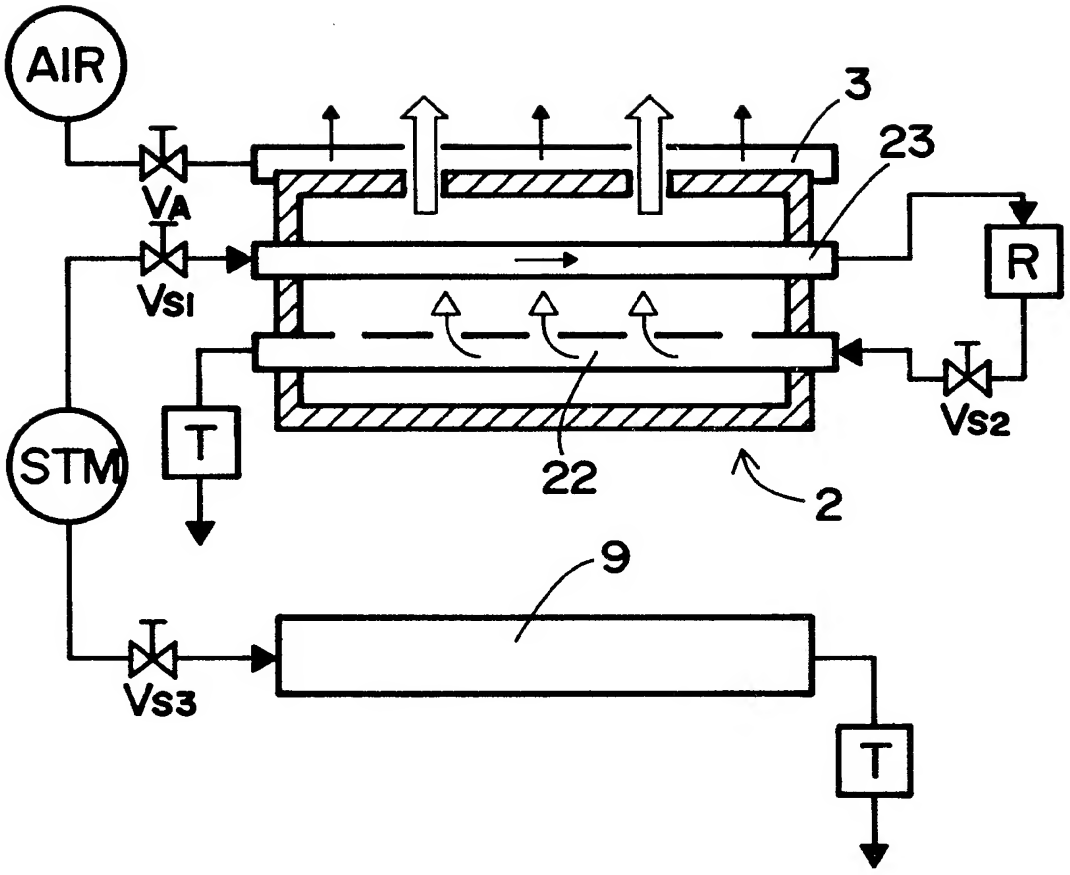


FIG. 4A.

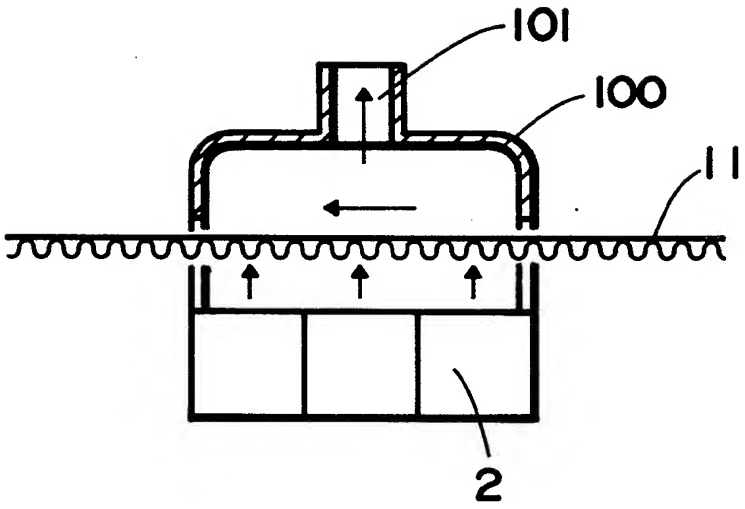
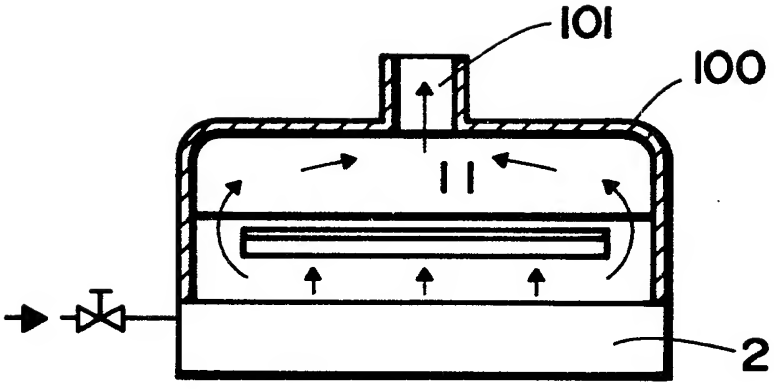


FIG. 4B.



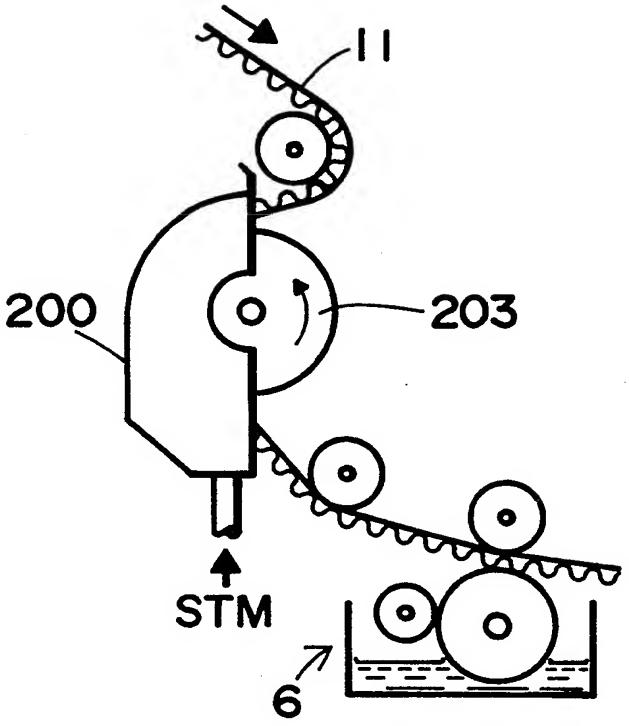


FIG. 5A.

FIG. 5B.